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ANDREA BEATTY RINIKER
Director

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504-6811 • (206) 753-2353

M E M O R A N D U M
July 19, 1985

To: Harold Porath

From: Dale Clark DKC and Marc Heffner mark

Subject: Winthrop Wastewater Treatment Plant Class II Inspection and Receiving Water Study, August 21-22, 1984

INTRODUCTION

During August 21-22, 1984, a Class II inspection was carried out by the Washington State Department of Ecology (WDOE) at the Winthrop Wastewater Treatment Plant (WTP). The inspection was requested by the WDOE Central Regional Office. The study objectives were to:

1. Determine if the WTP was complying with the effluent limitations given in its National Pollution Discharge Elimination System (NPDES) permit (No. WA-002085-5).
2. Provide information on the treatment efficiency including a description of plant design and operation.
3. Determine hydraulic and organic loading capacity, pump station capacity, and estimate future potential loading capacity of the facility.
4. Compare WDOE and WTP laboratory results and review laboratory procedures.

A brief receiving water study was performed as part of the inspection. The Methow River was surveyed in the vicinity of the outfall to determine water quality and assess the impact of effluent discharged to the system.

Participants in the inspection included Dale Clark, Otis Hampton, Marc Heffner, and Harold Porath, all of WDOE, and Steve Wilson, WTP operator. Review of laboratory procedures was performed by Dale Clark, Otis Hampton, and Steve Wilson. The write-up task was divided so that Marc Heffner prepared the treatment plant results and discussion section and Dale Clark wrote the remainder of the report.

SETTING

The Winthrop WTP is located south of Riverside Avenue and Perry Street in the town of Winthrop, Washington, near the bank of the Methow River, Okanogan County (Figure 1). Plant operation began in 1973. Residential housing and various small businesses are the major contributors to the plant. New recreational and tourist facilities and residential housing expansion are planned in the service area, in part due to a new, large, destination downhill ski resort currently being planned nearby.

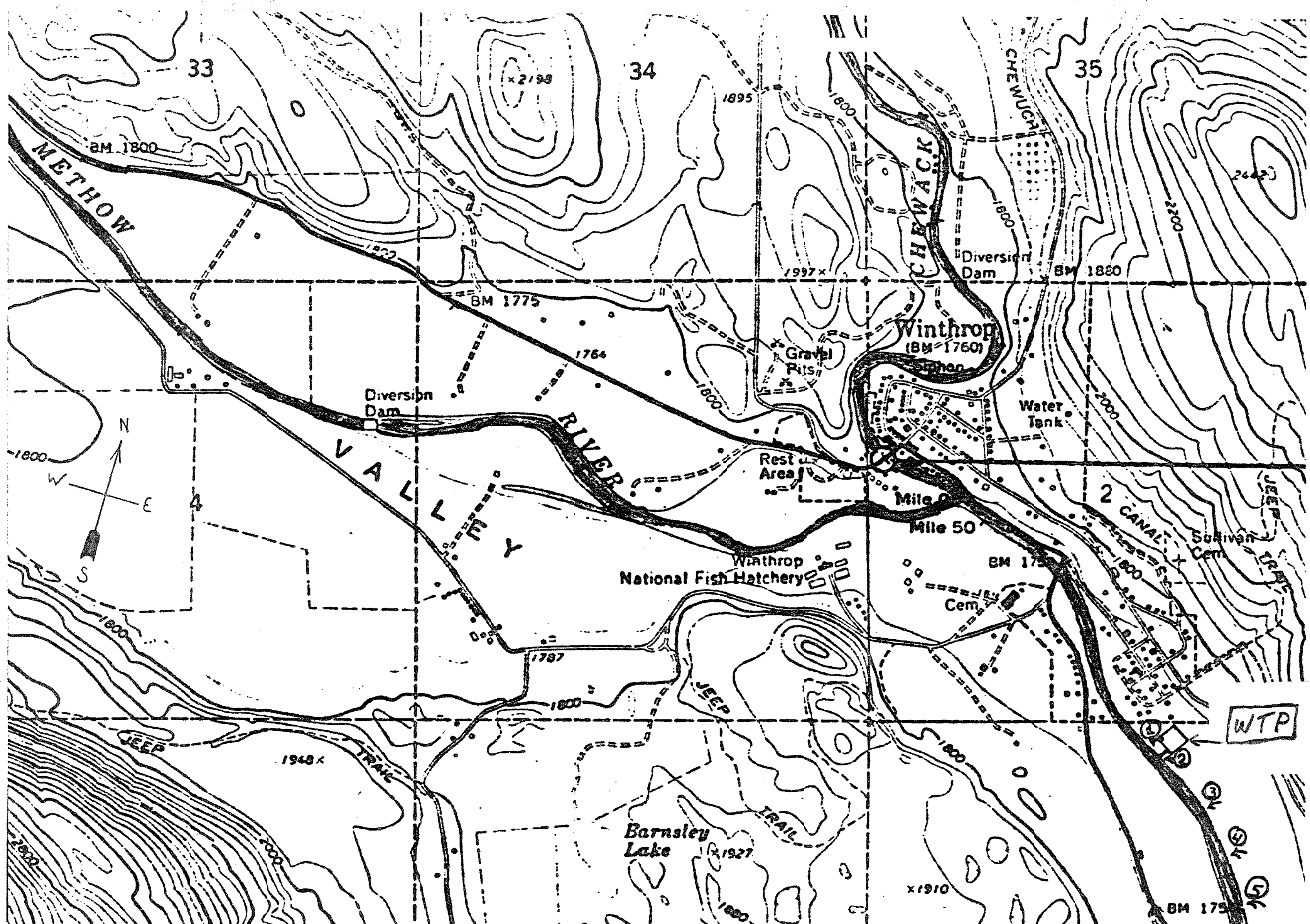

Figure 1. Winthrop wastewater treatment plant and receiving water study station location map - Winthrop, August 1984.

scale: 1:16,500 1 : Recicuing Water Study Sampling locations

The WTP is a pond system with three cells; an aerated pond, a polishing pond, and a chlorination pond (Figure 2; Appendix A, Figure 1). Influent is pumped to the WTP via a lift station located approximately 200 yards northwest of the facility into the aerated pond where settling and treatment occurs. From the aerated pond, the wastewater flows into the polishing pond for further treatment. A routing box located between the two treatment ponds can route the ponds through a drain line for maintenance or emergency purposes. The ponds are drawn down during late summer and fall to accommodate the hydraulic loading expected during the winter months. Originally, the aerated pond was designed to be a waste stabilization pond; however, odor problems required installation of an aeration system.

Discharge from the plant is primarily spray-irrigated (Appendix A, Figure 2). Wastewater is taken from the polishing pond wet well (Appendix A, Figure 3) and is spray-irrigated along the northwest and southwest fence lines of the WTP. The wet well also serves as the chlorination contact chamber during spray-irrigation. Chlorine is used only when effluent is sprayed next to the river. The WTP has the option of discharging to the Methow River via the chlorination pond and an outfall line with a bank discharge. During river discharge, the chlorination pond is used for disinfection. At present, receiving water discharge occurs on an infrequent basis (zero to two times per year).

In addition to the ponds, two small service buildings are located on the plant grounds. One building houses the chlorine-feed regulator, chlorine storage tank, and the spray-line pump (Appendix A, Figure 3). The other building houses the aeration-system compressor for pond 1. Due to a lack of space, laboratory facilities are located off-site at the city maintenance building.

A flock of sheep are kept within the fenced boundary of the WTP compound for grass and weed control.

WTP influent flow is estimated by multiplying the number of hours per day that the lift pumps are operated times the rated pump flow. This is the only method available for determining flow.

METHODS

Grab and composite samples were collected by WDOE and WTP at the locations shown in Figure 2. The field and laboratory analyses are listed on Table 1.

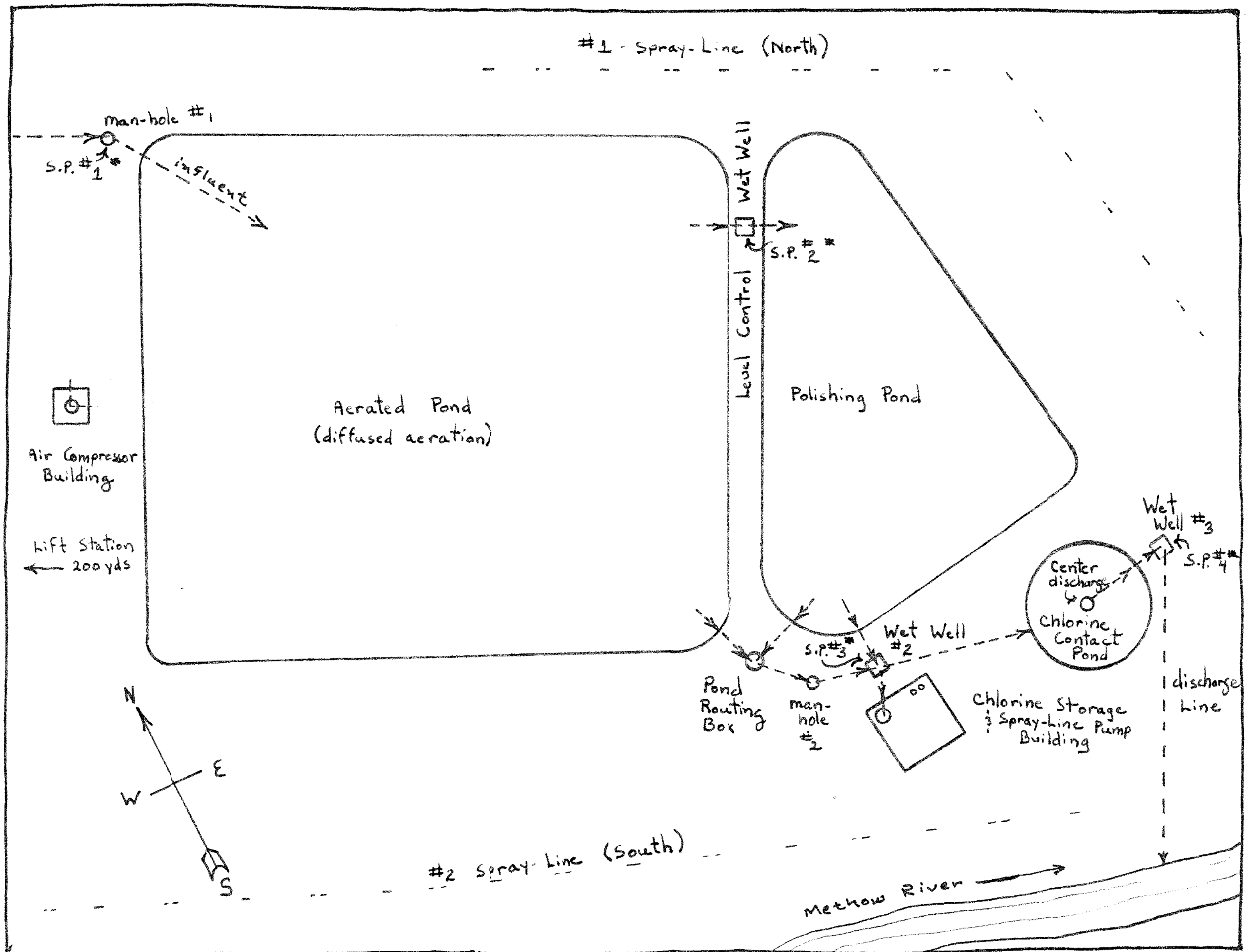

Figure 2. Flow diagram-Winthrop WTP, 8/84.

* SP# = Sampling Point

Table 1. Sample collection schedule for Class II inspection - Winthrop, August 1984.

24-hour Composite Samples*

Sample	Sampler	Installation Date (time in - time out)		Location
Influent	WDOE	8/21/84	0825 - 0825	Lift station 200 yards north of plant boundary
Aerated lagoon effluent	WDOE	8/21/84	0850 - 0850	Wet well between aerated and polishing ponds
Polishing pond effluent	WDOE	8/21/84	0915 - 0915	Polishing pond wet well
Chlorine pond effluent	WDOE	8/21/84	0930 - 0930	Chlorine contact pond at discharge pipe entrance

Grab Samples

Sample	Collection Date (time)	Laboratory Analyses	Field Analyses
Influent	8/21/84 (0825)		pH, temperature, conductivity
	(1630)		pH, temperature, conductivity
	8/22/84 (0825)		pH, temperature, conductivity
Aerated lagoon effluent	8/21/84 (0850)		pH, temperature, conductivity
	(1535)		pH, temperature, conductivity
	8/22/84 (0850)		pH, temperature, conductivity,
Polishing pond effluent	8/21/84 (0915)		pH, temperature, conductivity, dissolved oxygen
	(1010)		pH, temperature, conductivity, dissolved oxygen, total chlorine residual
Chlorine contact pond effluent	8/21/84 (0930)		pH, temperature, conductivity
	(1515)		pH, temperature, conductivity
	8/22/84 (0900)	Fecal coliform	pH, temperature, conductivity

*WDOE laboratory analyses included: pH (S.U.); turbidity (NTU); specific conductivity (umhos/cm); COD, BOD (five-day); nutrients (NO_3-N, NO_2-N, NH_3-N, O-PO_4-P, total-P); solids (total, total non-volatile, total suspended, total non-volatile suspended); alkalinity (as $CaCO_3$); fecal coliform (col/100 mL).

Winthrop laboratory analyses of the WDOE composite samples included: BOD (five-day) and suspended solids.

Samples were collected at four sites during the inspection: (1) influent lift station, (2) aeration pond effluent, (3) polishing pond wet well, and (4) chlorination pond final effluent (Figure 2). Composite samples were collected at each site using a WDOE Manning automatic composite sampler set to collect 250 mL every 30 minutes. The four sites were sampled for about 24 hours. The WTP operator collected single grab samples of both influent and effluent at approximately 0900 hours on August 22 for laboratory analysis.

Immediately following collection, WDOE and WTP samples were split for later analyses by the WDOE and Winthrop laboratories (Table 1). Samples for WTP analysis were transported to the off-site laboratory. The WDOE samples were placed on ice prior to transporting them to the WDOE Environmental Laboratory in Tumwater, Washington.

Flow was estimated by multiplying the pump hour meter readings times the estimated pump capacity (150 gpm pump at 85 percent efficiency = 128 gpm) as is done by the operator.

Memo to Harold Porath
Winthrop Wastewater Treatment Plant Class II Inspection and Receiving Water Study, August 21-22, 1984

During the Class II inspection, a boat survey was conducted to measure pond sludge depth and near-surface dissolved oxygen (D.O.) concentrations. In-field observations on general plant maintenance and condition were also recorded.

On August 22, 1984, the receiving water study was carried out to determine the effect of effluent discharged from the Winthrop WTP to the Methow River (a Class A state water). Rhodamine dye (250 mL) was added to the waste stream at the chlorination pond wet well, and grab samples were collected in the dye path downstream from the site of the effluent discharge (Figure 1). Station descriptions and parameters measured are noted on Table 2.

Table 2. Sample collection schedule for receiving water study - Winthrop, August 1984.

Station	Time*	Site Description	Laboratory Analyses	Field Analyses
1	1140	Methow River 15 yards above discharge	pH (S.U.); turbidity (NTU); spec. cond. (umhos/cm); COD; nutrients (NO3-N, NO2-N, NH3-N, O-PO4-P, total-P); solids (TS, TNVS, TSS, TNVSS); fecal coliform (col/100 mL)	temperature, dissolved oxygen
Effluent	Comp.	Effluent chlorine contact pond	Same as above.	pH, conductivity
2	1145	Methow River at discharge	Same as above.	temperature, dissolved oxygen
3	1150	Methow River 100 yards blw. discharge	Same as above.	Same as above.
4	1155	Methow River 200 yards blw. discharge	Same as above.	Same as above.
5	1200	Methow Rier 300 yards blow. discharge	Same as above.	Same as above.

*All samples collected on August 21, 1984.

RESULTS AND DISCUSSION

Treatment Plant

Composite and grab sample data collected during the inspection are presented in Tables 3 and 4. The operator reported that the chlorine contact pond was not being used as part of the flow scheme. Spray-irrigation was the only discharge being used, with draw-off for irrigation coming from the polishing pond wet well which can be used for chlorination during spraying (irrigated effluent is chlorinated only prior to using the spray line closest to the river). The polishing pond wet well is located just upstream from the chlorine contact chamber. Thus the polishing pond effluent sample is probably most reflective of treatment plant operation during the inspection. Data collected were fairly typical of domestic influent and secondary effluent. In-plant removals of total inorganic nitrogen (TIN-N) (influent approximately 16 mg/L, effluent approximately 3 mg/L) and total PO_4-P (influent approximately 8 mg/L, effluent approximately 4 mg/L) may have occurred, but single-day measurements from a long-detention-time facility renders such observations inconclusive.

Table 3. Composite sample data - Winthrop, August 1984.

		Laboratory Analyses																Field Analyses		
				Solids (mg/L)						Nutrients (mg/L)										
Sample	Sampler	BOD_5 (mg/L)	COD (mg/L)	TS	TNVS	TSS	TNVSS	Spec. Cond. (umhos/cm)	Turb. (NTU)	NO_3-N	NO_2-N	NH_3-N	TIN-N	O-PO_4-P	T-PO_4-P	Alk (mg/L as $CaCO_3$)	pH (S.U.)	Temp (°C)	pH (S.U.)	Spec. Cond. (umhos/cm)
Influent	WDOE	240	360	480	210	200	14	477	120	0.10	<0.10	16	16.1	3.8	7.2	190	7.2	3.7	7.7	520
	WTP*	280	370	550	240	180	29	572	190	<0.10	<0.10	22	22	3.9	8.2	220	7.8			
Aerated pond effluent	WDOE	48		370	190	63	1		54	<0.10	<0.10	7.0	7.0	3.8	5.5	160	7.8	2.9	7.6	445
Polishing pond effluent	WDOE	20	110	290	160	4	<1	377	23	<0.10	<0.10	2.5	2.5	3.4	4.8		7.3			
Chlorine contact pond effluent	WDOE	38	180	360	2	27	2	345	34	<0.10	<0.10	2.6	2.6	2.5	3.4	140	9.4	3.6	9.6	370
	WTP*	29	140	330	1	16	1	353	21	<0.10	<0.10	3.6	3.6	2.6	3.7	140	9.1			

*Grab sample collected at approximately 0900 hours on August 22, 1984.

Table 4. Grab sample data - Winthrop, August 1984.

			Field Analyses					Laboratory Analysis
Sample	Date	Time	Temperature (°C)	pH (S.U.)	Conductivity (umhos/cm)	Total Residual Chlorine (mg/L)	Dissolved Oxygen (mg/L)	Fecal Coliform (col/100 mL)
Influent	8/21	0825	18.5	7.8	483			
		1630	21.7	7.6	455			
	8/22	0825	17.9	8.1	550			
Primary pond effluent	8/21	0850	18.7	7.4	445			
		1535	20.0	7.5	450			
	8/22	0850	19.4	7.3	440			
Polishing pond effluent	8/21	0915	16.0	7.0	395		0.4	
		1010	17.2	7.5	340	1.5	0.7	
Chlorination pond effluent	8/21	0930	19.5	9.2	370			
		1515	25.7	10.0	350			
	8/22	0900	19.3	9.4	360			88, <1

Flow-measurement data are presented on Table 5. The flows were estimated using the influent wet well pump hour meter measurements multiplied by 85 percent efficiency for the two 150 gpm pumps (gpm rating provided by the operator). The 150 gpm pump rating was double-checked by the operator as this rating was lower than the 200 gpm rating included as part of an earlier capacity estimate (Haggarty, 1978). The pump station appeared adequate during the inspection, as the pumps alternated cycles and there was a total pumping time of 7.1 hours during the inspection. Single-pump capacity was not exceeded during any of the intervals checked. NPDES flow monitoring at the plant is presently being done one day per week as directed by the permit. It is recommended that the days that the meter is read be selected so that actual total weekly and monthly flows can be calculated and included in the DMR. Also, hourly meter readings once per month would be useful to estimate peak flows and excess capacity remaining at the pump station.

Table 5. Flow measurements at influent lift station* - Winthrop, August 1984.

Date	Time	Pump #1 Reading (hours)	Pump #2 Reading (hours)	Real Time (hours)	Pumping Time (hours)	Flow Rate (MGD)	Flow Rate (gpm)
8/21	0830	8649.8	8834.2				
				4.5	2.0	0.082	57
	1300	8650.8	8835.2				
				3.4	1.1	0.060	41
	1625	8651.3	8835.8				
				16.1	4.0	0.046	32
8/22	0830	8653.3	8837.8				
Flow for 24-hour sampling period				24	7.1	0.055	38

*Operator reported that two 150-gpm pumps are in the lift station. Flow rates are based on 85 percent efficiency (128 gpm).

Table 6 compares WDOE data to NPDES permit limits. The polishing pond effluent fell within permit limits for parmeters checked. The practice of irrigating directly from the chlorination wet well with minimal contact time causes some concern about possible fecal coliform violations. Fecal coliform sampling during irrigation is suggested to assure that the discharge falls within coliform criteria for irrigation systems (WDOE, 1978, p. 248). The irrigation criteria are for total coliforms; so to allow use of the fecal coliform test for this monitoring, it is suggested that an estimate of 5 total coliforms per 1 fecal coliform be used (EPA, 1976, p. 94). Thus, multiplying the total coliform criterion by one-fifth would provide a suitable fecal coliform criterion. The BOD_5 concentration and pH of the chlorine contact chamber effluent exceeded NPDES permit limits. This was not surprising since the contact chamber was not being used and the water in it was stagnant and covered with duckweed.

Table 6. Comparison of WDOE Class II inspection data to NPDES permit limits - Winthrop, August 1984.

Parameter	Final Effluent		Polishing Pond Effluent		NPDES Permit limits	
	Composite	Grab	Composite	Grab	Monthly	Weekly
BOD_5						
(mg/L)	38		20		30	45
(lbs/day)	17.4		9.2		20	30
(% removal)	84		92		85	
TSS						
(mg/L)	27		4		75	110
(lbs/day)	12.4		1.8		50	75
(% removal)	86		98			
Fecal Coliform (col/100 mL)		<1, 88			200	400
Chlorine Resid. (mg/L)				1.5*	Sufficient to maintain FC limit	
pH (S.U.)		9.2, 10.0, 9.4		7.0, 7.5	$6.0 \leq pH \leq 9.0$	
Flow (MGD)		0.055†			0.08††	

*Sample collected from wet well used for Cl_2 addition.

†Influent flow.

††Effluent flow.

Capacity of the WTP is difficult to estimate. Dimensions and volumes of the individual cells are estimated on Table 7 from a plan view of the plant (Thompson, 1971). The WTP was originally designed to serve approximately 800 people based on a design criteria of 200 persons/acre, but when the population served was about 400, an odor problem began to occur (Haggarty, 1978). The plant operator reported that although he was not operator prior to the installation of the aeration system, he did note an odor from the lagoons when working in the nearby fields during the summer. Table 8 compares plant size to present design criteria. It is estimated that plant capacity of the unaerated system is adequate to serve a population equivalent of approximately 400. The estimated capacity of 400 suggests that the odor problem was likely caused by an organic overload of the system.

Table 7. Treatment unit sizes - Winthrop, August 1984.

Unit	Shape	Maximum Operating Depth (feet)*	Horizontal Dimensions (feet)**	Surface Area at Maximum Operating Depth (acres)	Volume at Maximum Operating Depth (MG)††
Areated pond	rectangular	5.5	430 x 330	3.26	5.3
Polishing pond	triangular	4.5	225 x 295†	0.76	1.0
Chlorine contact pond	circular	4.7	78***	0.11	0.11

*Assumes 1.5 feet of freeboard, depth taken from plans and specs plan view (Thompson, 1971).
**Best estimate based on measurements from plans and specs plan view (Thompson, 1971).
***Approximate diameter.
†Base and height.
††Side slope of 3:1 assumed based on plans and specs plan view (Thompson, 1971).

Table 8. STP capacity estimate based on an unaerated system - Winthrop, August 1984.

Design Criteria*	Lagoon Size	Capacity Estimate	Inspection Loading
Total surface area loading 20 lbs BOD_5/acre/D	4.02 acres	80 lbs BOD_5/D approx. 400 people**	110 lbs BOD_5/D
1st Cell surface area loading 50 lbs BOD_5/acre/D	3.26 acres	163 lbs BOD_5/D	110 lbs BOD_5/D

*WDOE 1978.
**Based on 0.2 lb BOD_5/cap/D (WDOE, 1978).

Table 7 also estimates the volume of the chlorine contact pond to be approximately 0.11 MG. This estimate is much higher than the plan view estimate of 13,300 gallons, but it appears likely that the plan view estimate is in cubic feet rather than gallons (Thompson, 1971). The volume is of concern because the WDOE criteria call for a one-hour minimum detection time and two-hour maximum detention time at average flow (WDOE, 1978). At the present influent flow, detention time in the contact pond would be approximately 48 hours, far in excess of the two-hour maximum. The long detention time would require excessive chlorination in order to maintain a desirable chlorine residual effluent concentration. The chlorine contact facility should be modified prior to regular use.

Storage capacity available in the plant prior to needing regular discharges into the river is estimated in Table 9. An additional available storage capacity of 0.9 MG is estimated, which when allocated over the 6.5-month storage period would serve less than 50 additional people. Also, included in Table 9 is an estimated requirement of 2.2 acres for irrigation to draw down the ponds for winter storage at the approved monthly average application rate of 0.5 inch/day. Recordkeeping to document application rates is recommended.

Table 9. Controlled discharge operation water balance estimate - Winthrop, August 1984.

Storage Available

Aerated Pond

Volume at 5.5' level - volume at 2.0' level = storage available
5.3 MG - 1.8 MG = 3.5 MG

Polishing Pond

Volume at 4.5' level - volume at 2.0' level = storage available
1.0 MG - 0.4 MG = 0.6 MG

Total storage available = 4.1 MG

1984-85 summary

Storage used	Aerated Pond Depth* (feet)	Aerated Pond Volume Used (MG)	Polishing Pond Depth* (feet)	Polishing Pond Volume Used (MG)	Total Volume Used (MG)
prior to winter storage	2.5	2.3	2.0	0.4	2.7
after winter storage - (prior to discharge)	5.5	5.3	3.0	0.6	5.9
Total storage used		3.0		0.2	3.2 MG

Winter flow

Sewage
0.038 MGD (average winter flow from DMRs) x 6.5 months x 30 days/month = 7.4 MG

Precipitation (based on average rainfall during winter months - see Appendix B)
10.5 inches of rain falling on 4.02 acres of pond = 1.1 MG

Total input = 7.4 + 1.1 = 8.5 MG

Flow - storage = percolation + evaporation
8.5 MG - 3.2 MG = 5.3 MG

Because evaporation is probably minimal during this time period (the Wenatchee Weather Service is the closest known station with evaporation data; they only collect data from April through September), all loss is assumed to be due to percolation.

Percolation Rate
5.3 MG in 6.5 months = 0.25 inch/day. This equals the 0.25 inch/day maximum limit, so lagoon percolation is considered acceptable.

Additional Storage available

Total storage availabe - volume used for storage = additional storage available
4.1 MG - 3.2 MG = 0.9 MG

The additional storage is adequate for a population equivalent increase of 46 assuming a flow of 100 gpd and a storage period of 6.5 months.

Present sprayfield requirement

Assumptions (for 5.5-month spraying season) (NOTE: all assumptions are approximate)

Influent flow 55,000 gpd (based on inspection flow), 9.1 MG per season.
Evaporation losses 30.5 inches (see Appendix B), 20,000 gpd or 3.3 MG per season.
Percolation losses at 0.25 inch/D, approximately 27,000 gpd or 4.5 MG per season.
Precipitation 4.1 inches, 3,000 gpd or 0.5 MG per season.
Winter storage 3.2 MG or 19,000 gpd.

Flow to sprayfield

Flow = influent + winter storage + precipitation - evaporation - percolation
= 9.1 MG + 3.2 MG + 0.5 MG - 3.3 MG - 4.5 MG
= 5.0 MG

Average flow to sprayfield approximately 30,000 gpd

Minimum acreage requirement at maximum NPDES permit rate of 0.5 inch/day = 2.2 acres

*Depths are operator's estimates.

During periods when the aerated pond is not being operated at full design depth, some blower adjustments may be necessary. The O & M manual for the aeration system notes that full design depth should be maintained over the aeration tubing at all times (Hinde, P. 11, item 3.1.2[a]). Tom Dobras of Hinde Engineering (Dobras, 1985) noted that failure to do so could result in: (a) poor oxygen transfer efficiencies at less than completely full depth because the air is being forced out at too great a pressure, (b) possible higher blower operating temperatures, and (c) possible aeration tubing ice damage. Monitoring and adjusting aeration pressure and using care to avoid ice damage are recommended when lagoon levels are changed.

Capacity estimation of the aerated system is made somewhat difficult due to the large volume of the lagoon and relatively small air supply (a supply of 98 scfm per blower is reported by Haggarty (1978). Tom Dobras agreed with the Haggarty report in estimating that a population equivalent of approximately 720 should be served by operating one 98-scfm blower and using the other as standby (Dobras, 1985). The estimate was based on the ability of the aeration system to provide 245 lbs/D of O_2 and thus satisfy approximately 125 lbs/D of BOD_5. The 720 population equivalent apparently assumes 0.2 lbs BOD_5/cap/D and 0.17 lbs BOD_5/cap/D removed. Those numbers seem reasonable, but because most aerated lagoon equations consider air supply in conjunction with lagoon volume and detention time, confirmation of capacity estimates with equations is impractical. An illustration of this problem would be: based on MOP/8 aerated lagoon sizing criteria, a five-foot-deep lagoon would need a volume of approximately 2.0 MG to serve a population equivalent of 720 (WPCF, 1977), whereas the Winthrop lagoon volume is 6.3 MG.

A sampling grid was set up in an effort to gain more insight into how the lagoon was handling the inspection load. D.O. concentrations near the surface and sludge depths at various locations in the lagoons were measured (Figures 3 and 4). D.O. concentrations in the aerated lagoon were quite low (median concentration 0.4 mg/L) during the 1100 to 1150 hours sampling. Unfortuantely, a thick mat of duckweed covered the entire pond during the sampling effort, preventing subsurface light penetration and likely causing a high D.O. demand due to algal respiration in the pond below the duckweed. The duckweed cover prevented interpretation of the D.O. data in relation to plant capacity. Several stations were resampled in the afternoon after a breeze had blown the duckweed to the influent end of the lagoon. D.O. concentrations in the uncovered section of the lagoon were good (4.6 to 9.4 mg/L), illustrating the need to remove the duckweed. Physical removal, although most labor intensive, is preferred because it eliminates the opportunity for a chemically-caused plant upset or a need to monitor the effluent for herbicide concentrations. Aerated lagoon sludge depths and polishing pond D.O. concentrations and sludge depths were acceptable. Some dike erosion was noted during the sampling. The operator was starting to riprap the dikes and was planning to continue the program to take care of the problem.

Based on plant capacity estimates, large increases in plant flow do not appear desirable. The inspection influent load to be satisfied of 96 lbs BOD_5/D ([influent concentration (240 mg/L) - permitted effluent concentration (30 mg/L)] x flow (0.055 MGD) x 8.34) is 77 percent of the aeration system design

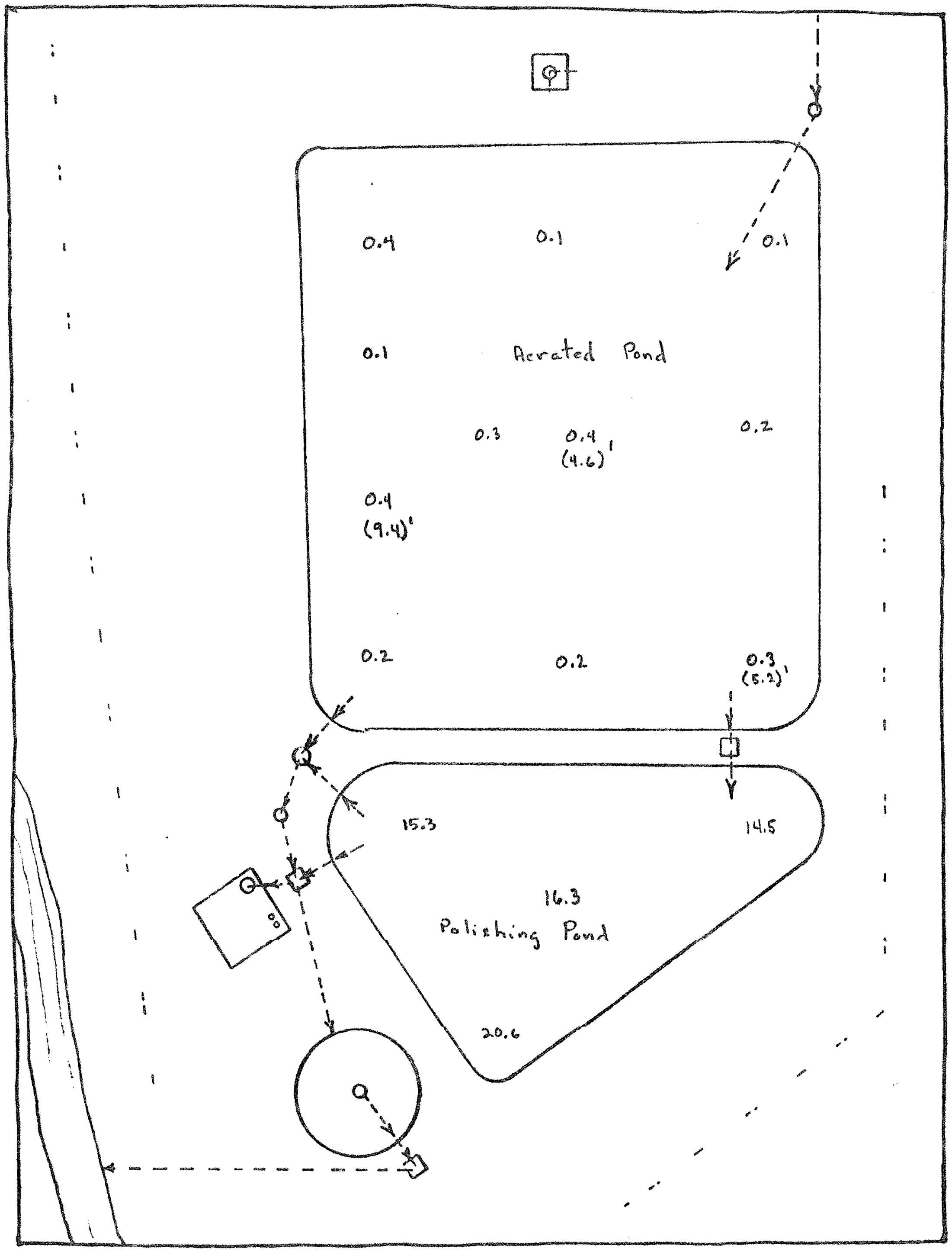

Figure 3. Dissolved oxygen (D.O.) concentration (mg/L) profile of the Winthrop WTP aereated pond and polishing pond for the WDOE Class II inspection, August 1984.

(o.o)' = D.O. concentration taken during afternoon

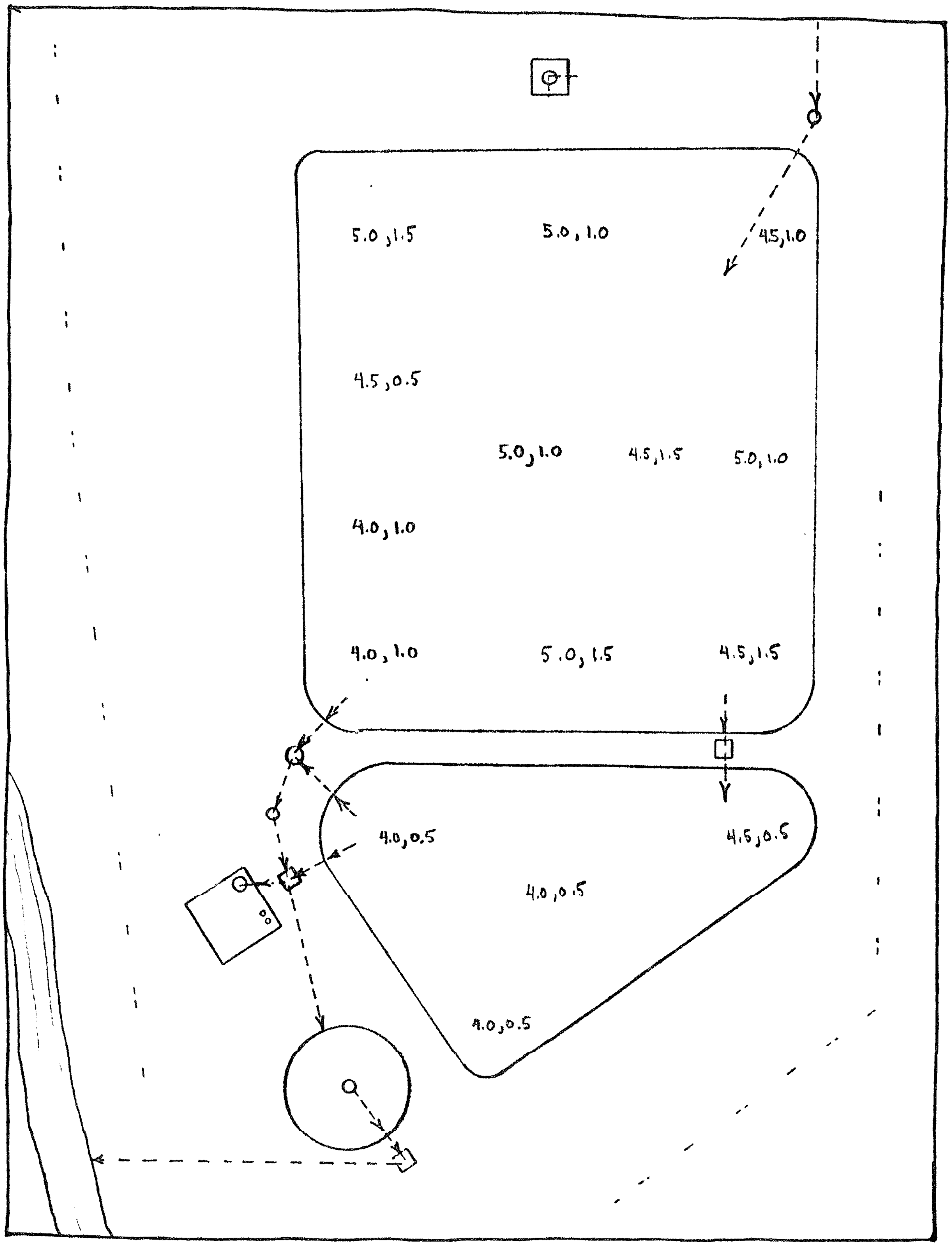

Figure 4. Pond depth (first number) and sludge depth (second number) profile of the Winthrop WTP aereated pond and polishing pond for the WDOE Class II inspection, August 1984.

estimate of 125 lbs BOD_5/D. In order to more thoroughly evaluate the system and increase the accuracy of capacity estimates, routine monitoring in excess of the minimum required by the NPDES permit is needed. Monitoring sugestions are noted on Table 10. Monitoring should be conducted during both discharge and non-discharge operation.

Table 10. Suggested additions to NPDES monitoring requirements - Winthrop, August 1984.

Test	Frequency	Influent	Aerated Pond	Aerated Pond Effluent	Polishing Pond	Polishing Pond Effluent	Final Effluent
Temperature	weekly	X	X		X		X
Dissolved oxygen	weekly	X		X		X	
	monthly		X*		X*		
BOD	2 times/month	X		X		X	
TSS	2 times/month	X		X		X	
Fecal coliform	2 times/month						X
Chlorine residual	daily**						X
Sludge depth	yearly		X***		X***		

*Minimum of four stations in the aerated lagoon and two stations in the polishing pond. Two sets should be taken on the same day; one before 0900 hours and one after 1300 hours.

**When discharging to either the sprayfield or river.

***Summer study with a minimum of nine stations in the aerated lagoon and three stations in the polishing pond.

Memo to Harold Porath
Winthrop Wastewater Treatment Plant Class II Inspection and Receiving Water Study, August 21-22, 1984

Receiving Water

Results of the receiving water study are presented on Table 11. Study results indicate that receiving water quality 300 yards downstream from the discharge was very close to that observed at station #1 upstream from the outfall. Physical parameters were reduced to background levels with the exception of pH, turbidity, nitrate, phosphates, and solids which demonstrated slight increases. All of the other parameters were similar or less than background levels found upstream from the discharge.

Table 11. Receiving water study results - Winthrop, August 1984.

			Laboratory Analyses															Field Analyses		
								Nutrients (mg/L)					Solids (mg/L)							
Station Number	Time*	Description**	BOD_5 (mg/L)	COD (mg/L)	pH (S.U.)	Spec. Cond. (umhos/cm)	Turb. (NTU)	NO_3-N	NO_2-N	NH_3-N	O-PO_4-P	T-PO_4-P	TS	TNVS	TSS	TNVSS	Fecal coliform (col/100 mL)	Temp (°C)	Dissolved oxygen (mg/L)	Dissolved Oxygen (% saturation)
1	1140	Methow River 15 yd. above discharge		8	7.9	120	1	0.08	<0.01	0.02	0.04	0.10	90	50	4	<1	4 est.	12.9	11.0	101
Effluent		Effluent chlorine pond	38	180	9.4	345	34	<0.10	<0.10	2.6	2.5	3.4	360	1	27	2	<1, 88			
2	1145	Methow R. @ discharge		110	8.0	356	25	<0.02	<0.02	2.4	2.4	3.2	300	160	10	2	80	17.5	5.0	52
3	1150	Methow River 100 yds blw. discharge		4	8.0	131	3	0.08	<0.01	0.15	0.19	0.20	90	65	<1	<1	10 est.	13.4	10.8	103
4	1155	Methow River 200 yds blw. discharge		4	7.9	122	1	0.12	<0.01	0.04		0.06	90	60	<1	<1	6 est.	13.0	11.1	105
5	1200	Methow R. 300 yds blw. discharge***		4	8.0	118	2	0.09	<0.01	0.01	0.07	0.07	80	55	1	<1	3 est.	12.9	10.8	102

*All samples collected on August 22, 1984.
**See Figure 2.
***Dye no longer visible.

Results of the dye study indicate effluent remained within ten feet of the riverbank for approximately 200 yards of travel and traversed about 50 percent of the river by 300 yards, the point where dye was no longer visible. The study suggests that the bank discharge results in poor mixing. It is recommended that the present bank discharge be further assessed as part of any engineering studies to increase plant capacity and, if necessary, be replaced with a mid-stream diffuser to allow for complete mixing in the 300-foot dilution zone as required by WDOE criteria (WDOE, 1978).

Due to stream depth, it was not possible to gauge flow. Flow was estimated to be at least 200 cfs based on conservative field estimates of velocity (1 foot/second), and size (100 feet wide, 2 feet average depth). Gauging measurements on the USGS gauging station on the Methow River at Twisp of 850 cfs of 8/7 and 355 cfs on 9/3 suggest that the >200 cfs estimate is reasonable. Based on 200 cfs stream flow and a plant flow of 0.055 MGD, the dilution ratio was about 2400:1, well above the state criteria of 20:1 (WDOE, 1978).

LABORATORY PROCEDURES REVIEW

The laboratory review consisted of four main elements: (1) Sampling Protocol, (2) Split Samples, (3) BOD Procedures, and (4) TSS Procedures.

1. Sampling Protocol

The Winthrop WTP operator uses single grab samples for all analyses. Influent samples are colleced at the lift station located approximately 200 yards north of the WTP (Figure 1). Effluent samples are collected either at the wet well located next to the chlorine storage building or at the chlorination pond outlet structure, depending on the type of discharge taking place. Chlorine is added to the effluent at the wet well when spraying is done next to the river, and at the chlorination pond during river discharge. Chlorine is not added when effluent is routed to the north spray-line for field application.

Grab samples are collected on a weekly or monthly schedule. Effluent is sampled only during periods of discharge as required by NPDES permit. Parameters analyzed for weekly are temperature (°C), pH (S.U.), D.O. (mg/L), and suspended solids (mg/L). Parameters analyzed for monthly are BOD (mg/L), TSS (mg/L), and FC (col/100 mL). Samples normally are collected in the morning (1000 hours). As noted previously (Table 10), additional monitoring is suggested to help better characterize plant behavior.

The single-grab method of sampling is vulnerable to brief slugs, yielding misleading results. Influent flow and loading varies substantially during a normal 24-hour sampling period. Loading from businesses and domestic sources is greatest during the day and may create a bias. A 24-hour composite sample is most preferable, although a hand composite (equal volumes at approximately 0800, 1100, 1400, and 1700 hours) should be adequate for the time being. Effluent quality is more homogeneous due to the lengthy retention time in the treatment pond. However, a composite sample should also be used to monitor final effluent quality to avoid any short-term anomalies.

2. Split Sample Results

The results of the WDOE 24-hour composite samples split with the Winthrop WTP are given in Table 12. Comparison of results indicated several substantial differences between WDOE and Winthrop laboratory results for the BOD_5 and TSS analyses. The WDOE roving WTP operator, Otis Hampton, had been requested to provide analytical training at Winthrop, and was on hand during the laboratory survey as part of the early stages of the training.

Table 12. Comparison of WDOE and WTP laboratory analyses of WDOE 24-hour composite samples - Winthrop, August 1984.

	Laboratory	BOD5 (mg/L)	TSS (mg/L)
Influent*	WDOE	240	200
	WTP	148	337
	Percent difference	38	41
Effluent**	WDOE	20	4
	WTP	25	46
	Percent difference	20	91

*Collected at the sanitary sewer lift station located 200 yards north of WTP.
**Collected at the polishing pond wet well.

3. BOD Procedures

Winthrop WTP uses the BOD laboratory procedure described in the WDOE BOD procedures guide (WDOE, 1977). Procedure review suggests that results could be improved based on the following:

a. The operator should dechlorinate effluent samples prior to analysis. Collection of the sample prior to chlorination or dechlorination and sample re-seeding of a chlorinated sample is necessary.

b. The five-day D.O. depletion for the blank is normally about 1.2 mg/L, much greater than the suggested <0.2 mg/L. The depletion may be due to contamination resulting from dirty glassware. Care should be taken to ensure clean glassware is used in the BOD analysis. Also, aging of distilled water used to make dilution water for one week in the dark in cotton-plugged jugs may help eliminate the problem.

c. The normal range of initial (zero-day) dilution water D.O. is 8.0 mg/L. This value is somewhat lower than the recommended 100 percent saturation which is 8.6 mg/L at 20°C and 1800 feet above sea level. The aging process described above may also help increase initial D.O. concentrations.

d. Incubator temperature is checked by a kitchen basting-type thermometer in a water bath. A log is not maintained. It is recommended that temperature be checked using a mercury thermometer immersed in a water bath located on the same shelf as the BOD samples. A log book should also be kept. Both of these procedures are needed to ensure a constant sample temperature of 20°C (±1°C). Incorrect incubator temperatures often result in erroneous results.

e. pHs of BOD samples should be checked prior to analysis to determine if they fall in the range of 6.5 to 8.5. If the pH is outside this range, the samples should be adjusted using sodium hydroxide or sulphuric acid. The meter is calibrated with buffers of 4 and 7. Due to the normal range of effluent samples (above 7), it is recommended that the pH meter be calibrated with buffers of pH 7 and 10.

The method used for determining BOD dissolved oxygen appeared to be acceptable. The operator uses a meter which is calibrated against D.O.s analyzed by Winkler titration whenever BODs are performed.

4. <u>Total Suspended Solids (TSS) Procedures</u>

TSS are determined based on <u>Standard Methods</u> (APHA, 1980). The samples are filtered through 9 cm glass fiber filters (Reeve Angel) and a Gooch crucible. The filters are prewashed and dried for one hour at 103°C. Following drying, the filters are cooled in a desiccator, weighed, and used immediately. Following filtration the filters and crucible are dried for one hour and allowed to cool in a desiccator prior to weighing and reweighing. The filters are not redried prior to the reweighing procedure.

The laboratory review did not identify any major problems with technique that would account for the analytical differences noted in the Split Sample section, above. The operator indicated that filter clogging caused by high algae concentrations results in long filter times (20 minutes). Recommendations for possible improvment of results includes the following:

a. Reduce the amount of sample to be filtered until filtration can be accomplished in five minutes.

b. Repeat drying and cooling cycle prior to reweighing until a constant filter weight is obtained or until the weight loss is less than 0.5 mg. This procedure is suggested until the operator becomes familiar with the drying times necessary. After familiarity is attained, redrying can be done occasionally as a quality assurance (QA) test.

SUMMARY AND CONCLUSIONS

During the Class II inspection, the polishing pond effluent at Winthrop fell within NPDES permit limits. Comments relative to points of concern discussed in this text include:

1. The influent lift station, reported by the operator to include two 150-gpm pumps, was adequate to handle the inspection flow using one pump as a primary pump and the other as a standby unit. Use of pump hour meters to estimate flows is acceptable, but data should be collected so total weekly and monthly flows can be calculated. Once per month, collection of hourly meter readings is suggested to more closely approximate reserve capacity at the station. Also, because of the large water losses associated with the lagoon system, estimation of effluent flows is suggested.

2. Treatment capacity at the plant is likely being approached. Observations included:

   a. The inspection flow exceeded the design limit based on WDOE criteria for operation of the unit as a stabilization pond without aeration (WDOE, 1978).

   b. In-plant storage capacity to avoid non-irrigation season discharges was estimated to be adequate to handle a population equivalent increase of approximately 50.

   c. It was estimated that during the inspection approximately 77 percent of the plant capacity (based on BOD_5 load) was being used for operation of the plant in the aerated lagoon mode.

   Additional plant monitoring (during both discharging and non-discharging plant operation) was suggested in the text (Table 10). The additional monitoring would provide more accurate plant loading and behavior information to better define plant capacity and serve as a design data base if an increase in capacity is necessary.

3. Good records to document spray-irrigation system application rates are necessary. Fecal coliform monitoring of the effluent being spray-irrigated, and chlorination prior to spraying when necessary to meet the coliform criteria is suggested.

4. Pressure adjustment of the blowers and caution to avoid ice damage of the aeration lines are suggested as part of the pond level fluctuations associated with winter storage.

5. The aerated lagoon was covered by a thick mat of duckweed during the inspection. The duckweed was likely responsible for the low D.O. concentration in the pond. The duckweed should be removed to encourage a higher D.O. concentration and better treatment efficiency. Physical means of removal is preferred.

6. The chlorine contact chamber was greatly oversized to the point that chances of efficient use of the unit is minimal. Modification of the unit prior to its routine use so that the unit meets WDOE design requirements is recommended. Once modified, the unit should be used prior to river discharge and as necessary to meet spray-irrigation coliform criteria.

7. The receiving water study found minimal impacts from the discharge on the Methow River. Outfall improvements to discourage the effluent from hugging the bank should be considered as part of any plant upgrade.

8. Laboratory inexperience was a problem at Winthrop. Training by the roving operator and practice of laboratory techniques are necessary. Specific problems are noted in the text.

DC:cp

Attachments

REFERENCES

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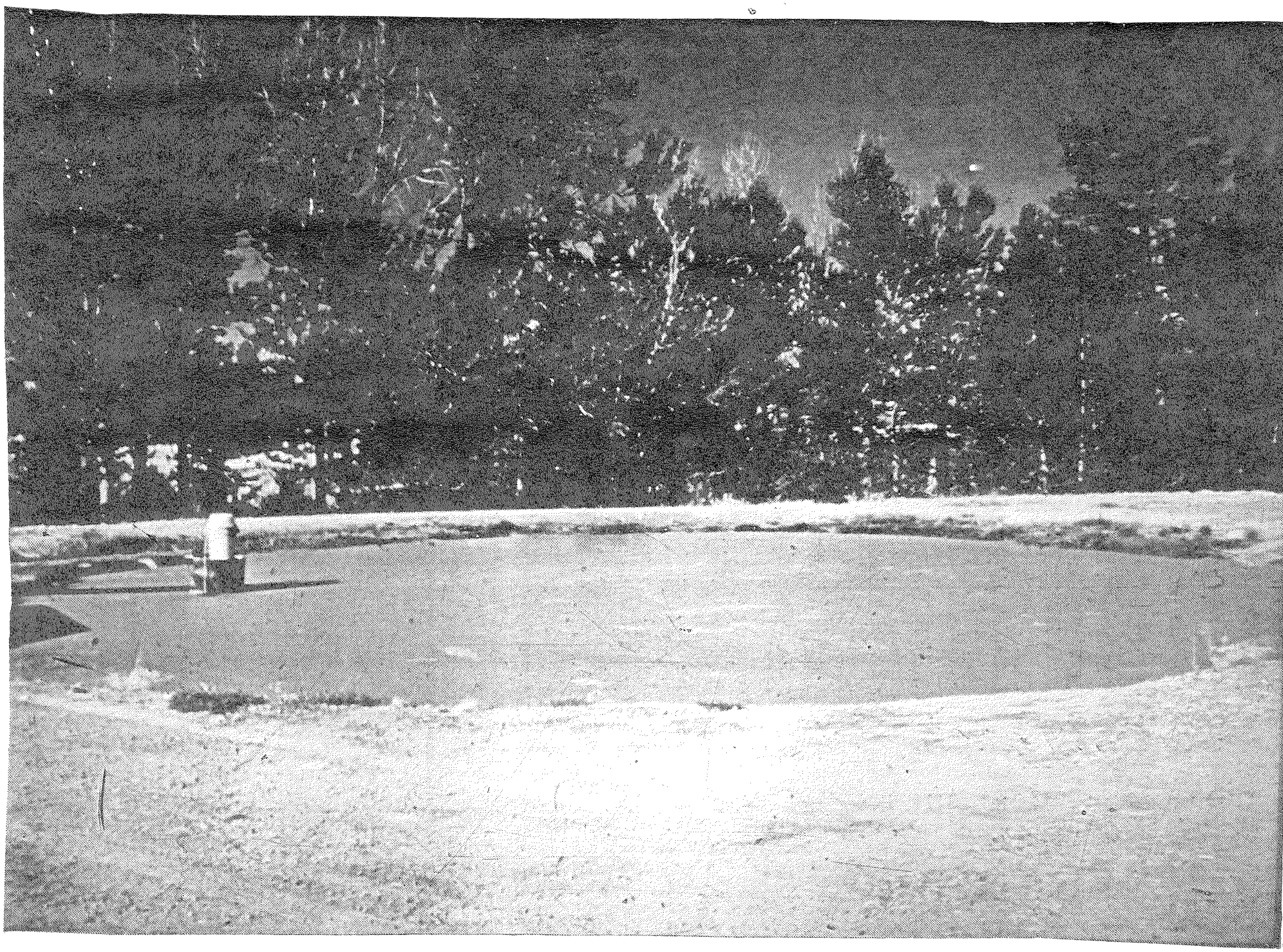
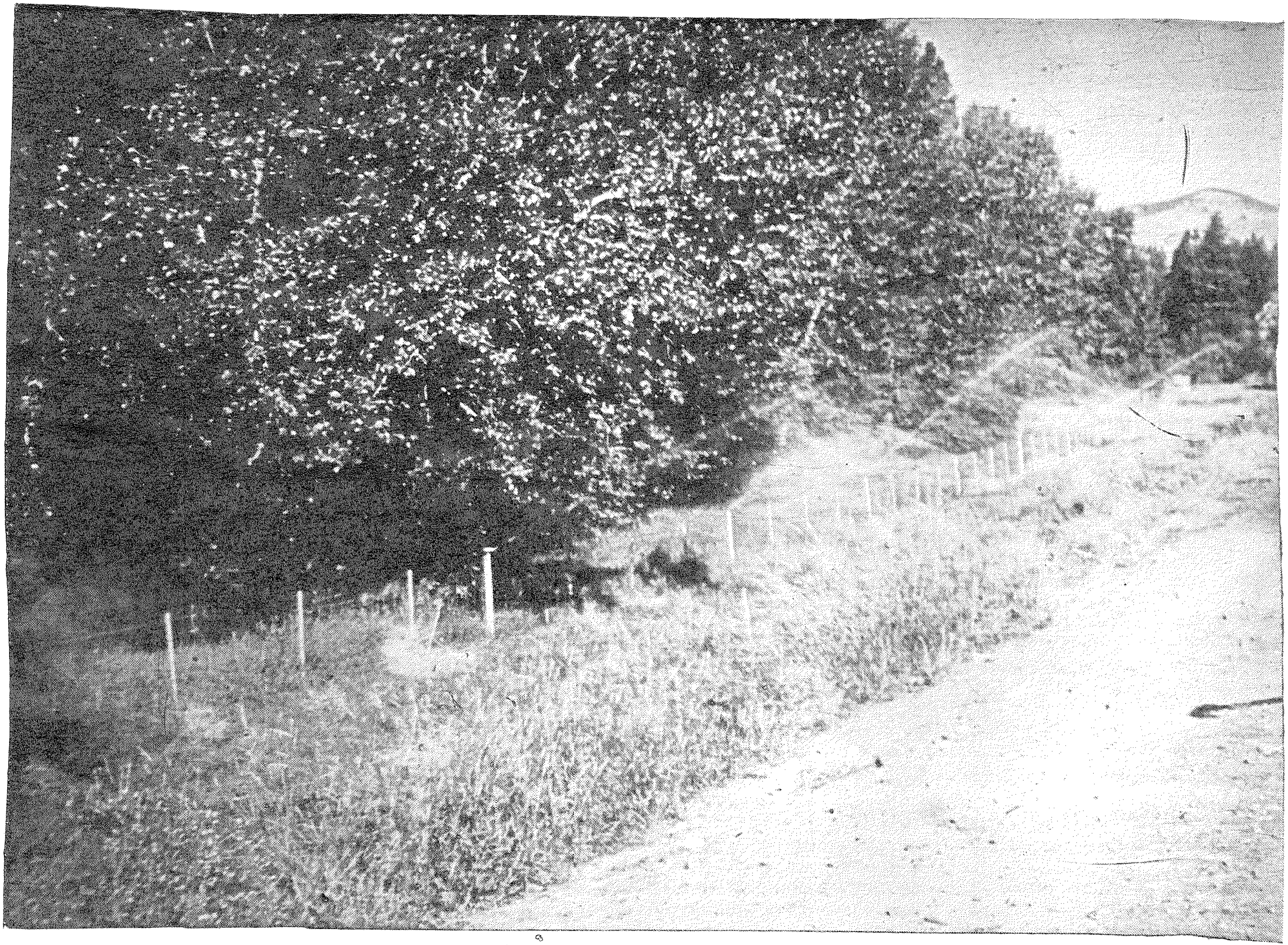
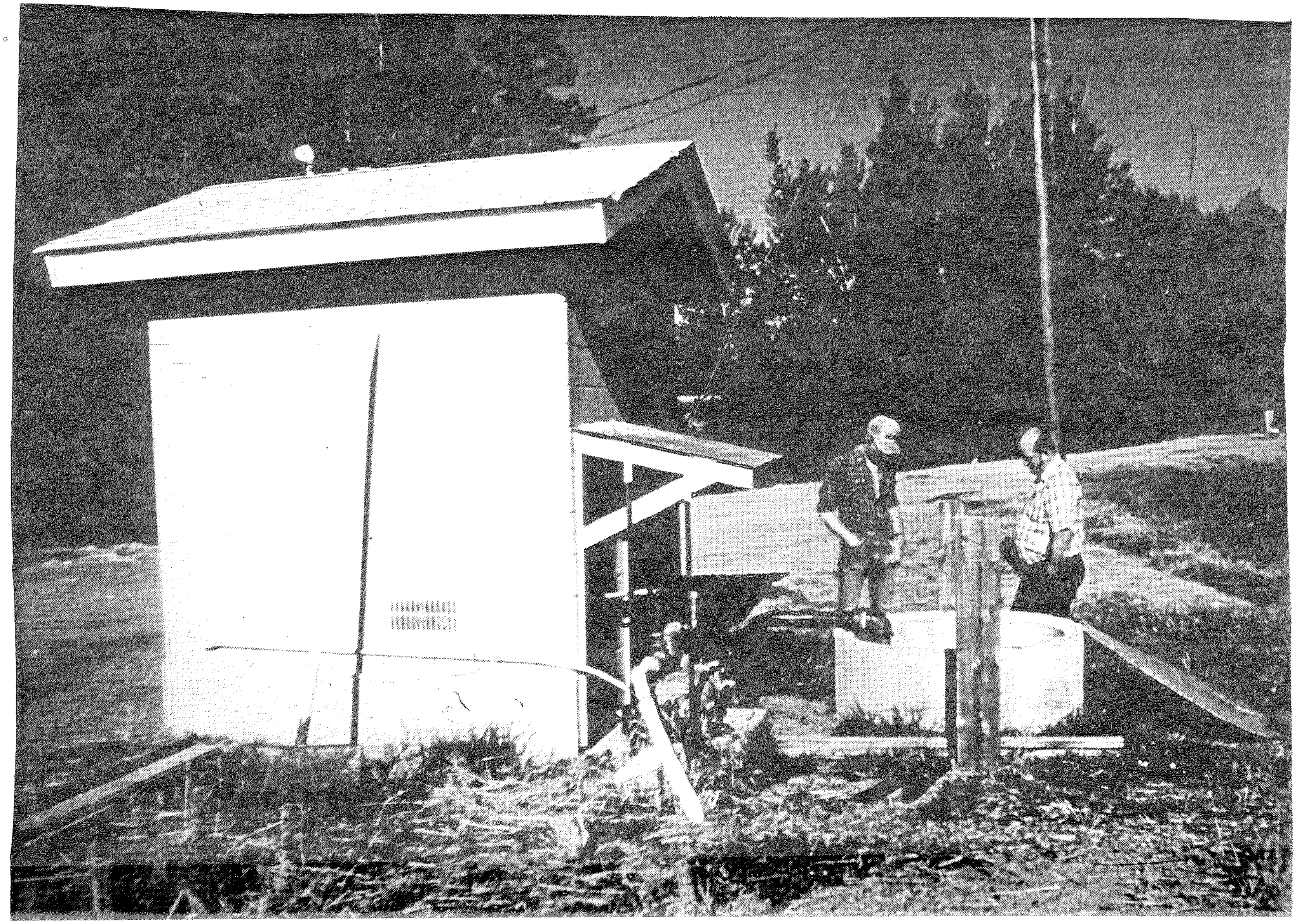


Appendix A, Figure 1. Polishing pond illustrating duckweed cover and 24-hour compositor placement, Winthrop WTP, 8/84.



Appendix A, Figure 2. Spray-irrigation line #2 adjacent to the Methow River (looking west), Winthrop WTP, 8/84.



Appendix A, Figure 3. Service building for chlorine-feed regulator, chlorine storage, and spray line pump. Note the polishing pond wet well used for chlorine contact and spray-irrigation wastewater sump, Winthrop WTP, 8/84.

Appendix B. Precipitation/evaporation - Winthrop, August 1984.

	Average† Precipitation (inches)	Pan Evaporation (mm/D) for Wenatchee*	Wind (naut. mi/D) for Wenatchee*	Pond Evaporation (mm/D)**	Monthly Evaporation*	
					mm	in.
January	2.35					
February	1.40					
March	0.89					
April	0.76	4.3	42	3	90	3.5
May	0.83	6.0	47	4.2	130	5.1
June	0.83	7.4	45	5.3	159	6.3
July	0.58	8.2	38	5.7	177	7.0
August	0.83	6.6	34	4.6	143	5.6
September	0.61	3.8	23	2.6	78	3.1
October	0.82					
November	1.78					
December	2.90					
Total	14.61					30.6

†Information provided for Winthrop by National Weather Service - Yakima.

*Information provided by the Wenatchee Weather Office. Evaporation for other months is considered minimal and not measured.

**Estimated using method from EPA, 1983.